

REMARKS

This responds to the Office Action mailed on December 10, 2004.

Claims 1, 9, 14, 22, 30, 51 and 55 are amended, no claims are canceled, and no claims are added; as a result, claims 1, 2, 4-10, 12-15, 17-23, 25-31, 33-37, 51, 52 and 54-56 are now pending in this application.

Information Disclosure Statement

Applicant filed Information Disclosure Statements on June 10, 2003; October 1, 2003; February 9, 2004; September 29, 2004; and November 12, 2004. To date, Applicant has not received initialed 1449 Forms indicating that any of the cited references were considered by the Examiner. Applicant respectfully requests that a copy of each of the 1449 Forms, listing all references that were submitted with the aforementioned Information Disclosure Statements, marked as being considered and initialed by the Examiner, be returned with the next official communication. Copies of each of the 1449 Forms are enclosed for the Examiner's convenience.

Additionally, Applicant submits another Supplemental Information Disclosure Statement and 1449 Form herewith.

§103 Rejection of the Claims

Claims 1, 2, 4, 14, 15, 17, 51, 52, and 54-56 were rejected under 35 USC § 103(a) as being unpatentable over Maiti (U.S. 6,020,024) in view of Park (U.S. 5,795,808), Brasen (U.S. 4,725,887), and Ma (U.S. 6,207,589). Applicant respectfully traverses this rejection.

Maiti apparently discloses a high dielectric constant metal oxide layer on a silicon nitride layer grown on the body region of a semiconductor device. The silicon nitride layer 14 is intentionally formed by Maiti by ion implantation of nitrogen, thermal nitridation of an oxide layer by ammonia, nitric oxide, nitrous oxide, or plasma/thermal processing. The nitride layer 14 is an integral and essential feature of Maiti, as seen from the discussion in column 3 of Maiti, and from the statement that the nitride “layer 14 will not have as much of an adverse effect on the overall effective gate oxide thickness (EOT) as the prior art SiO₂ processes” (*see* Maiti at column

3, lines 24-26). Applicant respectfully submits that a person of ordinary skill in the art would therefore understand that nitride layer 14 is an important part of the structure taught in Maiti.

By contrast, Applicant respectfully submits that the structure of the presently rejected claims is different from that of Maiti. Specifically, as noted above and in Applicant's prior response, Maiti includes a silicon nitride layer 14 between the high k metal oxide 16 and the substrate 12. The present claim language excludes such a layer, which creates a problematic series capacitance. (*See, e.g.*, Maiti at column 2, lines 5-10, and line 25, and column 3, lines 23-29.) Series-connected capacitors typically greatly reduce the effectiveness of MOS type transistors, and are therefore to be avoided. However, Maiti's arrangement requires high temperature oxidation anneals to "reduce the oxygen vacancies in the metal oxide film" formed by "metal sputtering". (*See id.* at column 3, lines 35-38.) This problem exists because Maiti uses highly energetic methods of forming the metal oxide 16, such as sputtering, which are known to typically cause surface damage and poor dielectric properties.

Applicant respectfully disagrees with the Office Action's statement that the cited reference discloses "an evaporation technique." Instead, Applicant submits that the only metal deposition technique described or suggested in Maiti is sputtering, which one of skill in the art would not consider a thermal evaporation technique, as disclosed in the present patent application. For example, Maiti refers specifically to sputtering at least at column 3 lines 37 and 46, and in claims 6 and 24. Applicant is unable to find in Maiti any disclosure, teaching, or suggestion of thermal evaporation of metal layers. Nor can Applicant find in Maiti any disclosure of the impact of rough surfaces on the leakage rate of the eventual dielectric layer. Thus, Applicant respectfully submits that the structure of the present claims is different from Maiti's structure, at least in there being an additional layer in Maiti. Moreover, even Maiti notes that this additional layer causes a problem. Moreover, the method of metal deposition in Maiti will increase surface roughness, unlike the subject matter of the present claims. Therefore, Applicant respectfully submits that Maiti teaches away from the present claims because Maiti discusses the series capacitance problem, but then provides a different structure from the present claims.

The cited references of Park, Ma, and Brasen have been discussed in the previous response, and are used in the outstanding Office Action to show that electron beam evaporation

is known. Applicant respectfully submits that these references do nothing to cure the above noted deficiencies in the primary reference, i.e., Maiti. Applicant specifically submits that the suggested combination of references, whether taken alone or in any combination, still does not describe or suggest “...*evaporation depositing a substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation, the metal being chosen from the group IVB elements of the periodic table; and oxidizing the metal layer to form a metal oxide layer directly contacting the body region ...*”, as recited in independent claims 1, 9, 14, 22, 30, 51 and 55, as amended herein. The amendment overcomes the Office Action’s statement in paragraph 8 that the wording of the claims reads on Maiti. Applicant has clarified that the metal layer is oxidized to be directly contacting the semiconductor body region, such that there is no additional unshown dielectric layer present.

Thus the suggested combination of references do not describe or suggest the structure of the independent claims. The dependent claims are believed patentable over the cited references at least as depending from patentably distinct base claims. Therefore, Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 22, 23, 25, 30, 31, and 33 were rejected under 35 USC § 103(a) as being unpatentable over Maiti (U.S. 6,020,024) in view of admitted prior art (pages 1-4), and further in view of Park (U.S. 5,795,808), Brasen (U.S. 4,725,887), and Ma (U.S. 6,207,589). Applicant respectfully traverses this rejection.

Maiti, Park, Ma and Brasen have been discussed above. The outstanding Office Action uses the “Applicant’s Admitted Prior Art” (“AAPA”) to show that it is well known in the art to use the metal oxide layer to form ICs, processors, mobile telephones and memory devices, including wordlines, sourcelines, bitlines and system busses. However, Applicant respectfully submits that the “AAPA” does nothing to correct the above noted deficiencies of Maiti and the other cited references to describe or suggest either the structure of the present claims, as amended herein, or to obtain the electrical results of the claimed arrangement, for many of the reasons already discussed above. Therefore, Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 5-7, 18-20, 26-28, and 34-36 were rejected under 35 USC § 103(a) as being unpatentable over Maiti (U.S. 6,020,024) in view of admitted prior art (pages 1-4), Park (U.S. 5,795,808), Brasen (U.S. 4,725,887), and Ma (U.S. 6,207,589) as applied to claims 1, 14, and 30, and further in view of Yano (U.S. 5,810,923). Applicant respectfully traverses this rejection.

Maiti, Park, Ma, Brasen and the “AAPA” have been discussed above. The Office Action uses Yano to show that electron beam evaporation of zirconium oxide at substrate temperatures of 300-700 degrees C is known. Applicant respectfully submits that even if the deposition of zirconium oxide were to be comparable to the deposition of zirconium metal, and even if the claimed temperature range of 150-400 deg C were comparable to the referenced 300-700 ° C, the result still would not describe or suggest all of the features of the independent claims, as amended herein, for many of reasons already given above. Therefore, Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 8-10, 12, 13, and 21 were rejected under 35 USC § 103(a) as being unpatentable over Maiti (U.S. 6,020,024) in view of Park (U.S. 5,795,808), Brasen (U.S. 4,725,887), and Ma (U.S. 6,207,589), and further in view of Moise (U.S. 6,211,035) and Yano (U.S. 5,810,923). Applicant respectfully traverses this rejection.

Maiti, Park, Ma, Brasen, Yano and the “AAPA” have been discussed above. The Office Action uses Moise to show that annealing and oxidizing a metal layer in a plasma of krypton and oxygen to form a dielectric layer is known. The rejection discusses the annealing in krypton and oxygen. Applicant respectfully submits that even if the suggested combination of references were permissible, the combination still does not result in the claimed combination of features. Specifically, the suggested combination of references still does not describe or suggest the previously noted features of an evaporated metal on the body layer of a transistor that is low temperature oxidized to form a metal oxide that is also directly contacting the body layer. Thus, even if there were somehow a suggestion to make the combination of references permissible, the result still does not describe or suggest the claimed features of the structure. Therefore, Applicant respectfully requests that this rejection be reconsidered and withdrawn.

Claims 29 and 37 were rejected under 35 USC § 103(a) as being unpatentable over Maiti (U.S. 6,020,024) in view of admitted prior art (pages 1-4), Park (U.S. 5,795,808), Brasen (U.S. 4,725,887), and Ma (U.S. 6,207,589), and further in view of Moise (U.S. 6,211,035). Applicant respectfully traverses this rejection.

The features of the cited references have all been discussed above with reference to the prior rejections. Moise is apparently used to show that the oxidation of a metal in krypton and oxygen plasma is known. However, as discussed above, Applicant respectfully submits that even if the suggested combination of references were permissible, it still does not result in the claimed combination of features. Specifically, it does not describe or suggest the previously noted features of an evaporated metal on the body layer of a transistor that is low temperature oxidized to form a metal oxide that is also directly contacting the body layer. Thus, even if there were some suggestion to motivate the combination of references, the result still does not describe or suggest the claimed features. Therefore, Applicant respectfully requests that this rejection be reconsidered and withdrawn.

AMENDMENT AND RESPONSE UNDER 37 CFR § 1.116 – EXPEDITED PROCEDURE

Serial Number: 09/945,535

Filing Date: August 30, 2001

Title: HIGHLY RELIABLE AMORPHOUS HIGH-K GATE OXIDE ZrO₂

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Dkt: 1303.026US1

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney, David Suhl, at 508-865-8211 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

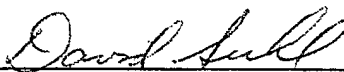
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By



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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Mail Stop AF, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 9 day of February, 2005.

KACIA LEE

Name

Kacia Lee

Signature